Rock Chips
Spring 2006

Alberta Geological Survey

Dr. Kevin Parks Named as New Manager of AGS

Following the retirement of Rick Richardson, Dr. Kevin Parks, P. Geol., has taken on the roles of Manager of the Alberta Geological Survey and Provincial Geologist. Dr. Parks has been with the Alberta Geological Survey for more than six years as senior hydrogeologist and has spent his professional career in energy and environmental geology in Alberta's private and the public sector.

The Alberta Geological Survey (AGS), as part of the Alberta Energy and Utilities Board (EUB), provides geoscience information and expertise needed by government, industry and the public for earth-resources stewardship and sustainable development in Alberta. New knowledge is always being generated by AGS and its partners through our ongoing geoscience programs and activities. From time to time, we find it necessary to realign our internal structure to keep pace with knowledge and technology, as well as the evolving priorities of the EUB and the Government of Alberta.

On April 1st, 2006, the AGS organizational structure took one more step on its evolutionary path to ensure AGS stays current and responsive to the geoscience knowledge needs of stakeholders and clients in a fast-changing world. The six internal section names and missions have been reset to reflect ongoing, basic Survey functions in contrast to topical program areas. The names and missions of each new section are as follows.

Mapping Section

The mission of this section is to map and understand the geology of Alberta. This includes all rock and sediment from the crystalline basement to the land surface, including the mountains, foothills, plains and boreal forest regions inside the provincial boundary. Long-term goals of AGS mapping programs will include an updated and unified Table of Formations of Alberta that includes new formations in the Precambrian rocks of northeast Alberta and the unconsolidated Tertiary and glacial deposits across the Province; a new lexicon of Alberta structural features; completion of surficial geology map-coverage in northern Alberta; and an updated bedrock geology map of the province. Partnerships with the Geological Survey of Canada will continue to be of central importance to AGS' success in the Mapping Section mission.

Resource Assessment Section

This section houses the original AGS mission and function assigned to Dr. John Allan by the Alberta Legislature in 1920; namely, to report on the mineral resources of Alberta to the government and people of the province. The mission of this section remains to tell Albertans and the world about the geology of Alberta's mineral and energy resources. Programs include our ongoing appraisal of the nature and age of Alberta's diamond-bearing rocks, examining our rare-earth and base-metal deposit potential; characterizing our industrial mineral wealth, including iron and building stone; supporting the study of unconventional fossil fuels, including CBM, tight or basin-centric gas in deep formations, shale gas and biogenic gas deposits; and understanding Alberta's uranium potential. This section is responsible for AGS initiatives supported by the Government of Alberta Mineral Development Strategy and the Alberta Energy Innovation Strategy.

Environmental Geology Section

The Environmental Geology Section houses our groundwater and geohazards programs. Its mission is to provide geoscience knowledge to EUB and Government of Alberta agencies for effective water-resource and land-use policy and regulation, particularly in areas of intensive energy development. It also provides geoscience expertise in support of the protection of

public safety from geological hazards in Alberta. The Environmental Geology section will maintain the Turtle Mountain Monitoring System and develop the Turtle Mountain Geological Field Laboratory. The Field Laboratory will provide data on landslides and safe access to the mountain for Canadian and international researchers. This section is also charged with completing the map of Alberta's Base of Groundwater Protection in support of energy-industry regulation by EUB's Environment Group and by Alberta Environment. It will also provide geoscience expertise to government groups regarding Alberta's Water for Life Strategy.

Energy and Subsurface Systems Section

This section will work in broad research coalitions to generate innovative, made-in-Alberta solutions to the increasing challenges in maintaining the balance between energy development and the environment. This section is delivering world-class geoscience in support of long-term carbon-dioxide and acid-gas sequestration in depleted oil and gas reservoirs and deep saline aquifers, which is key to maintaining Alberta's energy pre-eminence through oil-sands development and future application of clean-coal technology. The Energy and Subsurface Systems Section also supports investigations into Alberta's geothermal energy potential. The section's program activities support the Government of Alberta's Energy Innovation Strategy and Climate Change Strategy.

Knowledge Management Section

To preserve and manage the geological data and knowledge of AGS as an asset is the mission of the Knowledge Management Section. Knowledge management professionals will create and support standardized, transparent work flows for AGS geoscience programs, manage our centralized data stores and ensure AGS makes effective and appropriate use of information technology.

The Office of the Provincial Geologist

The OPG houses the Manager of the Alberta Geological Survey and the Provincial Geologist (a dual role) and our senior science advisors. These individuals provide leadership and strategy and ensure our programs are delivering on the overall AGS mission, as well as supporting EUB and Government of Alberta business priorities. The OPG is also tasked with anticipating the future geoscience needs of Albertans for program development. Through the efforts of the Corporate Services Team, the Office provides and co-ordinates internal corporate services in the areas of safety, finance, facilities, communications and marketing. ❖

Rock Chips is published four times a year by the Alberta Geological Survey in the spring, summer, fall and winter.

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Synoptic Geology and Resouces – Clear Hills Ooidal Ironstones (Part 2)

Part 1, a synoptic history of discovery of the Clear Hills ooidal ironstones was published in the Winter 2005 edition of Rock Chips. Part 2 provides an overview of the geology and summarizes the iron resources within the Bad Heart Formation.

The Bad Heart Formation is within Late Cretaceous Smoky Group, which was deposited about 92 million to 82 million years ago. The Smoky Group in the Smoky River region comprises five formations, which from stratigraphic top to base are

(a) Puskwaskau Formation, a sequence of dark grey mudstone to silty mudstone deposited in a 'deep' marine environment (i.e., mainly below wave base) and ranging from 90 m to 180 m thick in the Clear Hills. In the Smoky River to Clear Hills region, the Puskwaskau Formation is unconformably underlain by

(b) Bad Heart Formation, a sequence of 'shallow' marine (i.e., mainly deposited at or above wave base), frequently bioturbated sandstone, siltstone and, in places, ooidal ironstone banks. The ooidal ironstone banks range locally up to about 8+ m thick by kilometres or more in lateral and strike extent. At Smoky River, Donaldson (1997) suggested the Bad Heart Formation is unconformably underlain by

(c) Muskiki Formation, a sequence of dark grey mudstone to silty mudstone deposited in a 'deep' marine environment that locally is up to about 40 m thick. At Smoky River this unit is believed to be underlain by

(d) Cardium Formation, an interbedded sequence of mudstone, sandstone and, in places, chert pebble conglomerate deposited mainly in a shallow marine environment that is up to about 40 m thick. Lastly, the

(e) Kaskakapau Formation, a sequence of mainly deeper marine mudstone and sandstone up to 120 m thick. Within Kaskapau Formation there is a thin (less than 2 m thick) ooidal ironstone near its base and a "*granular siderite marker*" in the upper part of the formation (Varban and Plint, 2005). These lithologies indicate that ooidal ironstone and an 'ironstone matrix' are not uniquely present in the Bad Heart Formation.

In the Clear Hills region, the Puskwaskau Formation is overlain by late Late Cretaceous Wapiti Formation that consists predominantly of continental clastics with local coal lenses.

Donaldson and Plint (1999) suggested the Bad Heart Formation unconformably overlies the Muskiki Formation in the Smoky River area, but to the north in the Clear Hills, the Muskiki and Cardium formations have been eroded and the Bad Heart Formation unconformably overlies Kaskapau Formation. In the subsurface, to the west and southwest, the Bad Heart Formation is time-stratigraphically correlative with the Marshybank Formation, which consists mainly of deeper marine siltstone and mudstone and apparently contains no ooidal ironstones.

McLearn (1919) first described the Bad Heart Formation at and near the junction of the Bad Heart River with the Smoky River. He stated that the

"*Bad Heart sandstone...consists of 5 to 25 feet* [1.5 to 7.6 m] *of coarse sandstone, weathering reddish brown. It stands out prominently in all the cliffs* [along the Smoky River] *from Puskwaskau River to within a few miles of the Little Smoky and forms a horizontal, frieze-like band in the cliff walls of shale. This member is abundantly fossiliferous...*"(Figures 1 and 2).

Regional stratigraphic correlations by Chen and Olson (work in progress) for the Clear Hills to Smoky River region show that the Bad Heart Formation is eroded and thus not present across the wide Peace River valley (Figure 3).

Green and Mellon (1962) were the first to geologically map at 1:500 000 scale the known and inferred bedrock in both northern Alberta and the Clear Hills region, and they described in greater detail the geology of the Bad Heart Formation and the immediately encompassing units. Bertram and Mellon (1975) suggested that the Bad Heart Formation in the Clear Hills region was thickest at or near Rambling River, and thinned and had a lesser component of ooidal ironstone to the west and north. Donaldson (1997) geologically mapped a series of stratigraphic sections across Bad Heart Formation along the Smoky River, traced the unit westward into the subsurface based on well log information, and mapped a few stratigraphic sections of the unit at Rambling River. Donaldson (1997) recognized nine lithological facies within the Bad Heart Formation along the Smoky River that, in general, comprise from stratigraphic top to base

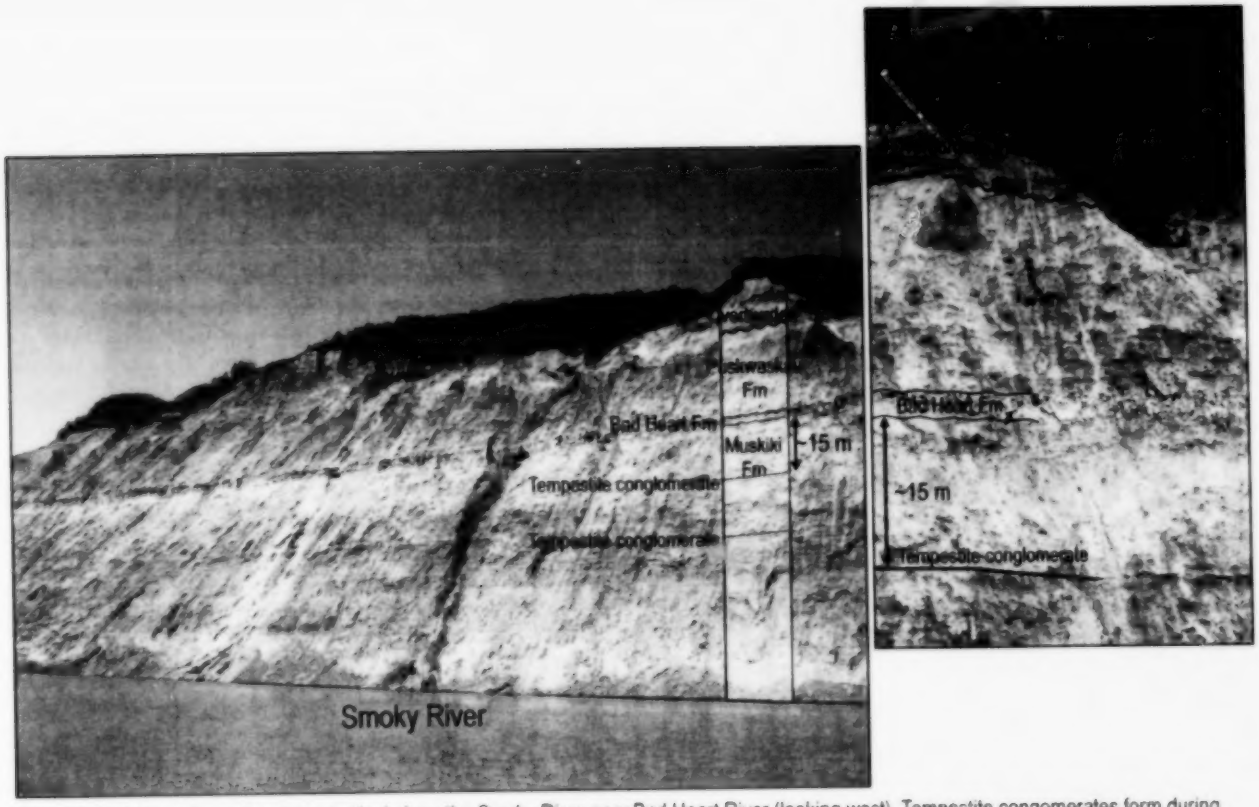


Figure 1. Bad Heart Formation 'type section' along the Smoky River near Bad Heart River (looking west). Tempestite congomerates form during cyclonic storms. Close-up image shows AGS geologists (in red) collecting palynology sampling from the Puskwaskau to upper Muskiki units at the Bad Heart type section. The close-up image is of the extreme right portion of the photograph on the left.

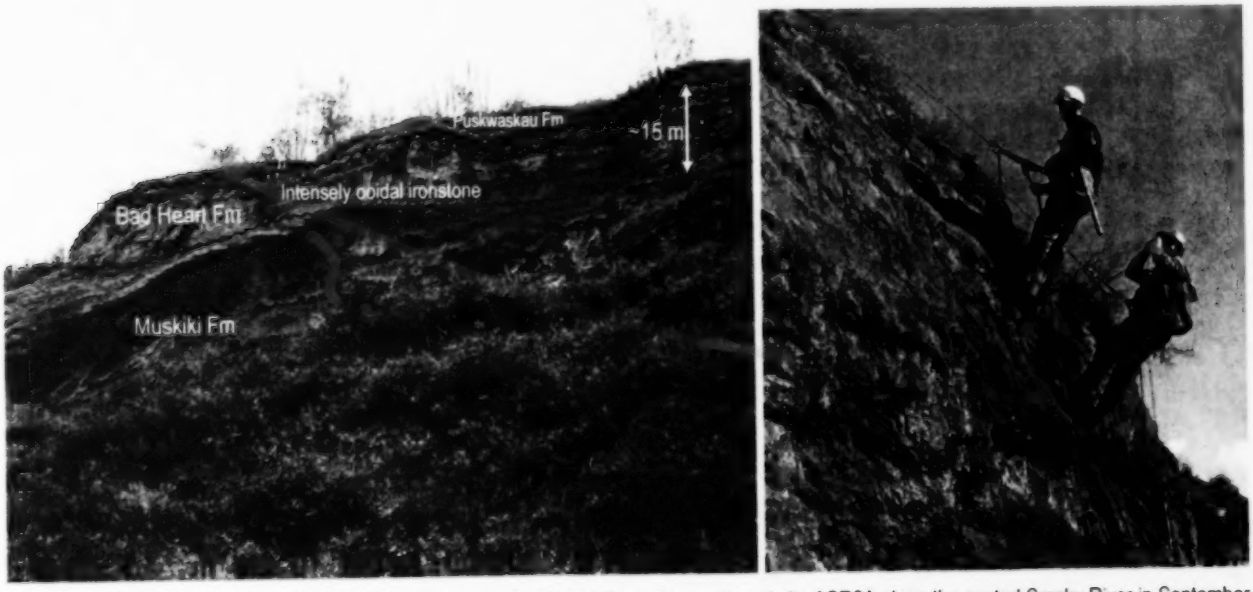
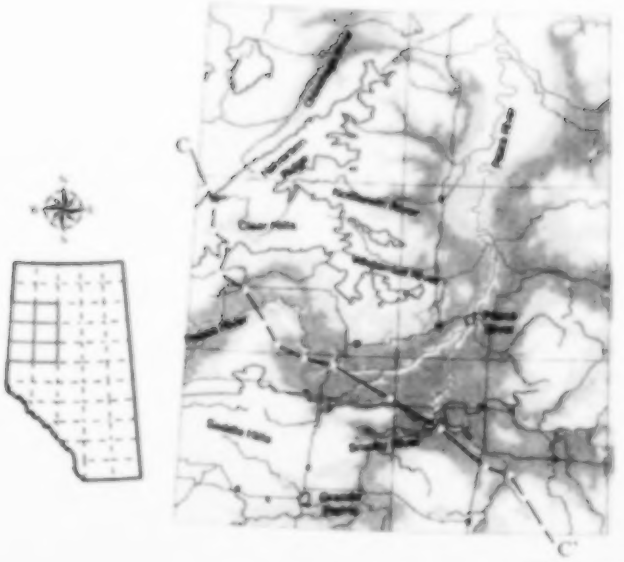


Figure 2. AGS geologists examining and rock sampling the Bad Heart Formation section at site ASR9A along the central Smoky River in September 2004. Here the Bad Heart Formation is thicker than at the type section and contains a thick ooidal ironstone in the lower Allomember 1.

Unit ID	Short description
I	Phosphatic oondal silty sandstone
H	Skolithos–burrowed silty sandstone (Skolithos is a trace fossil)
G	Oondal muddy sandstone
F	Thinly bedded sandstone
E	Bioturbated silty sand
D	Oondal ironstone
C	Thalassinoides–burrowed silty sandstone (Thalassinoides is a trace fossil)
B	Laminated mudstone
A	Chert and phosphate pebble conglomerate

Donaldson et al. (1999) suggested the Bad Heart Formation in the Smoky River region comprises two allomembers bounded by three discontinuities. Allomember 1 includes Facies A to D and Allomember 2 includes Facies C to H, with the bounding erosional surfaces occurring at the base (BES) and top (ES1) of Allomember 1 and at the top (ES2) of Allomember 2, where it is overlain by Facies I, which is either uppermost Bad Heart Formation or lowermost Puskwaskau Formation. With respect to the Clear Hills, Donaldson (1997) suggested the sedimentological record of the Bad Heart Formation is incomplete compared to that along the Smoky River. That is, in the Clear Hills, only Facies C and D are present, with possibly some E and F at the Rainbow River (Swift Creek) section. However, recent mechanical trenching and geological mapping of sections by the AGS in the southern part of the Clear Hills indicates the sequence at the Smoky River and the Worsley Pit area are similar (e.g. compare the two sections in Figure 4). The Smoky River section comprises a lower 'allomember' of sandstone and an overlying intensely oondal ironstone capped by a conglomeratic zone, which is overlain in turn by an upper 'allomember' consisting of sandstone and a thinner oondal ironstone at or near the top of the section. A similar situation exists at the Worsley Pit section. However, although the upper sandstone units are markedly thinner at the Worsley Pit, there is a clear separation by a conglomeratic layer of the lower intensely oondal ironstone from the overlying Bad Heart Formation clastic and oondal ironstone horizons.

Collom (2001) also studied the Bad Heart Formation along the Smoky River as part of his comprehensive Ph.D. study of the Wapiabi Formation from southwestern to northwestern Alberta. Collom, based largely on comparative macropaleontology, suggested Allomember 1 of the Bad Heart Formation at the central Smoky River is more closely correlative, at least from a paleontological age perspective, with uppermost Kaskapau or Muskiki formations. Whether or not such is true, from a purely lithological and sequence



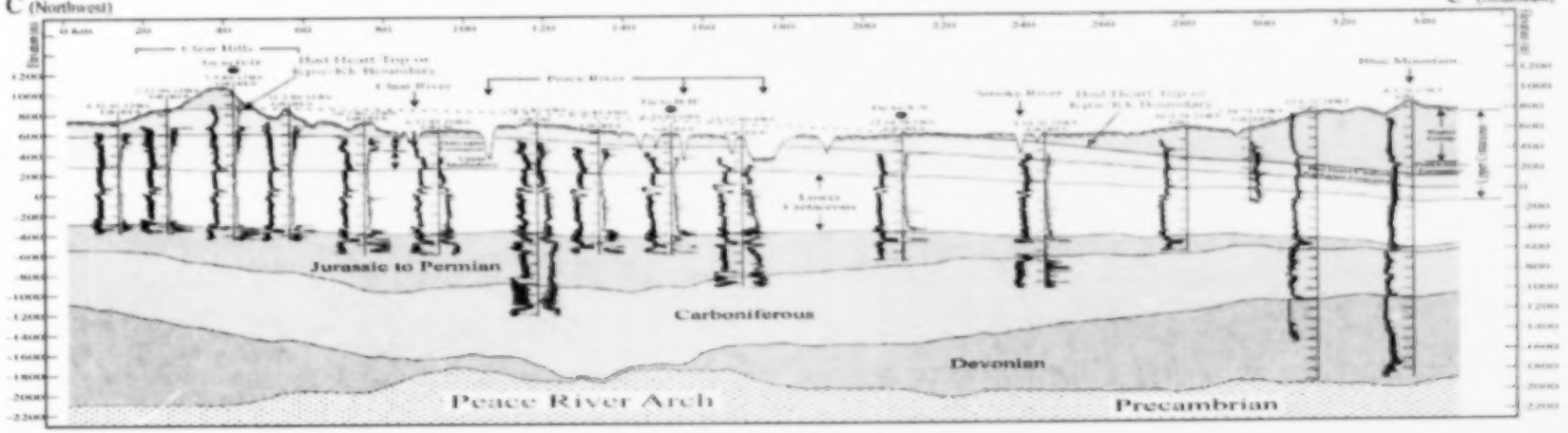


Figure 3. Regional cross-section C-C' from the southeastern Clear Hills to southeast of the Smoky River. Kpw — Cretaceous Puskwaskau Formation; Kb — Cretaceous Kaskapau Formation.

stratigraphic viewpoint, it seems logical to consider the Bad Heart Formation (i.e., allomembers 1 and 2) as a cohesive sequence stratigraphic package.

Regarding the known and inferred resources of ooidal ironstone within the Bad Heart Formation in the Clear Hills region, previous work by industry during the 1950s and 1960s, and by the AGS during the 1960s and early 1970s, indicated there is at least one billion tonnes of resource with an average grade of about 32% to 35% iron (note that this resource estimate would not now be compliant with the guidelines for resource/reserve estimates provided by Securities Commission National Instrument 43-101). The ooidal ironstone resources are in four main areas along the southern and eastern margins of the Clear Hills and are named Worsley, South Whitemud River, Whitemud River and Swift Creek (Rambling River) 'resource blocks' (Hamilton, 1998). Detailed information about the geometry, grade distribution and potential co-product or deleterious elements within each of these four 'resource' areas is currently lacking. As a result, the AGS initiated a three-year field and office study of the Clear Hills region in 2004 to address these and some other unknowns about the iron resources in the Clear Hills to Smoky River region. Results from this recent AGS study will be summarized in a subsequent article on the Clear Hills ooidal ironstones. ❖

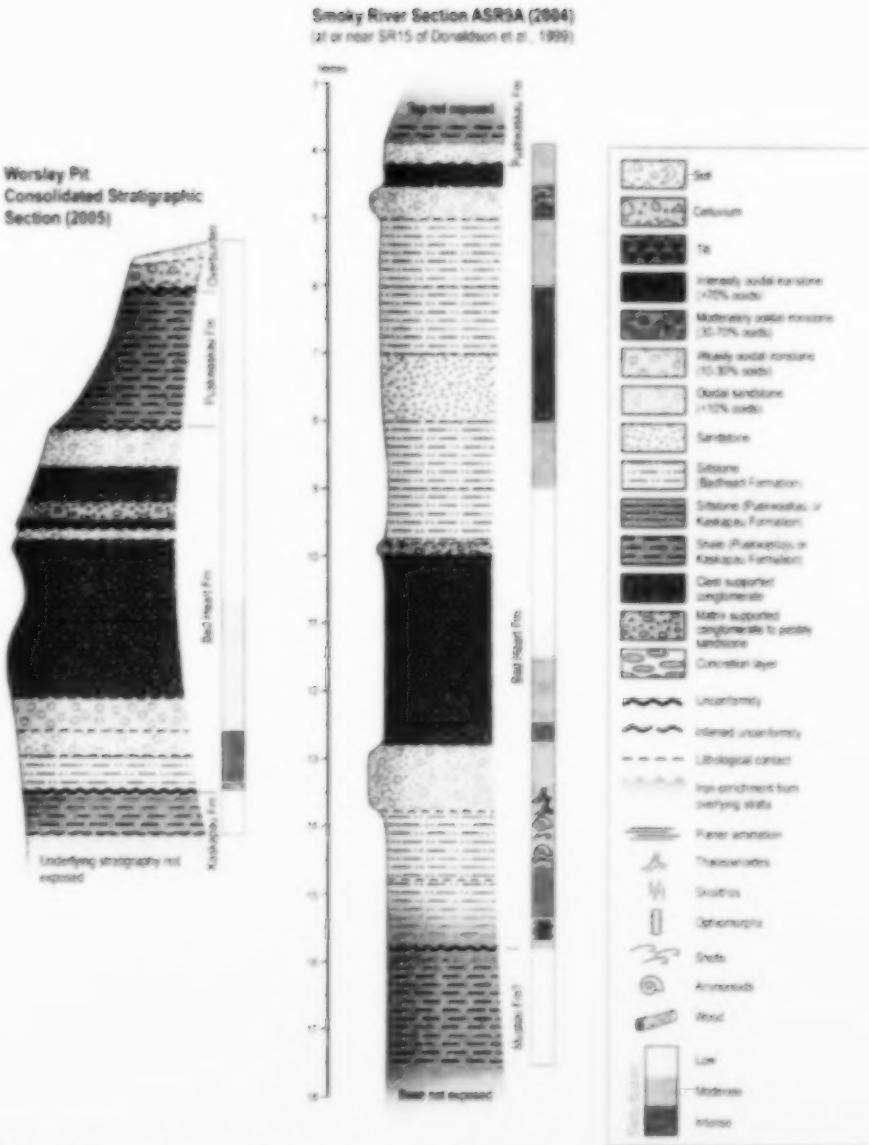
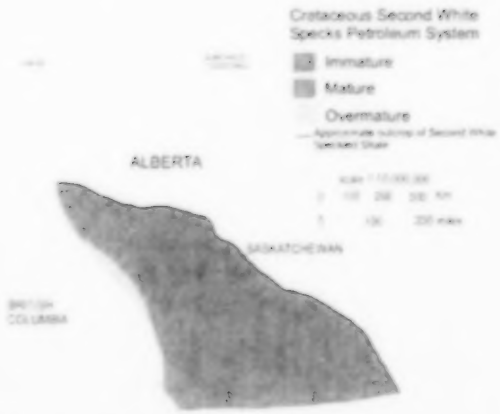


Figure 4. Comparative geology, Worsley Pit in the southern Clear Hills and central Smoky River.

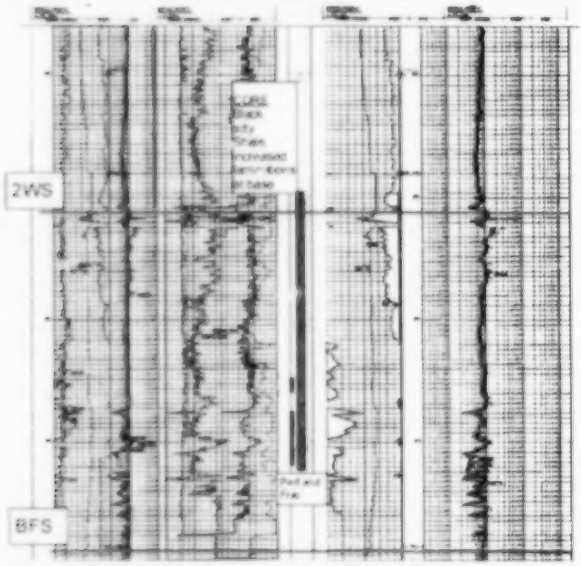
Shale Gas Resource Evaluation

AGS has initiated a project to evaluate shale gas resources in Alberta. 'Gas shale' is a generic term that includes gas from organic-rich lithologies, such as dark-coloured shale, interbedded shale/silt/sand, shale with dispersed silt including 'radiolarian' silt and shaley siltstone. The project will first evaluate the Colorado Group and progress to deeper strata.



Map displaying the Cretaceous Colorado Group Second White Specks (modified from the Geological Atlas of the WCSB, 1994).

The initial work will consist of a compilation of data, maps and cross-sections along with pertinent references leading to a series of detailed working models of Alberta shale gas plays with a comparison to U.S. shale gas plays. The data compilation will include a list of wells that have tested/perforated shales, detailed geochemistry (e.g., adsorption data, total organic content, maturity, etc.), sedimentology, structure (faults, fracture fairways), stratigraphy, mineralogy, thin section descriptions, completion and production data, gas-kick data from the EUB, and a resource estimation (original gas in place).



Logs from southeastern Alberta that identify shale gas production in the Second White Specks

New databases, maps and reports will be made available on the AGS website and will be continually updated. To a lesser extent, the compilation will include evaluating the correlation of shale geochemistry to log parameters in the Western Canada Sedimentary Basin (WCSB), hydrogeological influences and types of completion stimulation (i.e., types of fracs) that have aided economic success in the USA. ❖

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	or	
	Andrew Beaton	(780) 427-3272
Clear Hills Oolidal Ironstones	Reg Olson	(780) 427-1741

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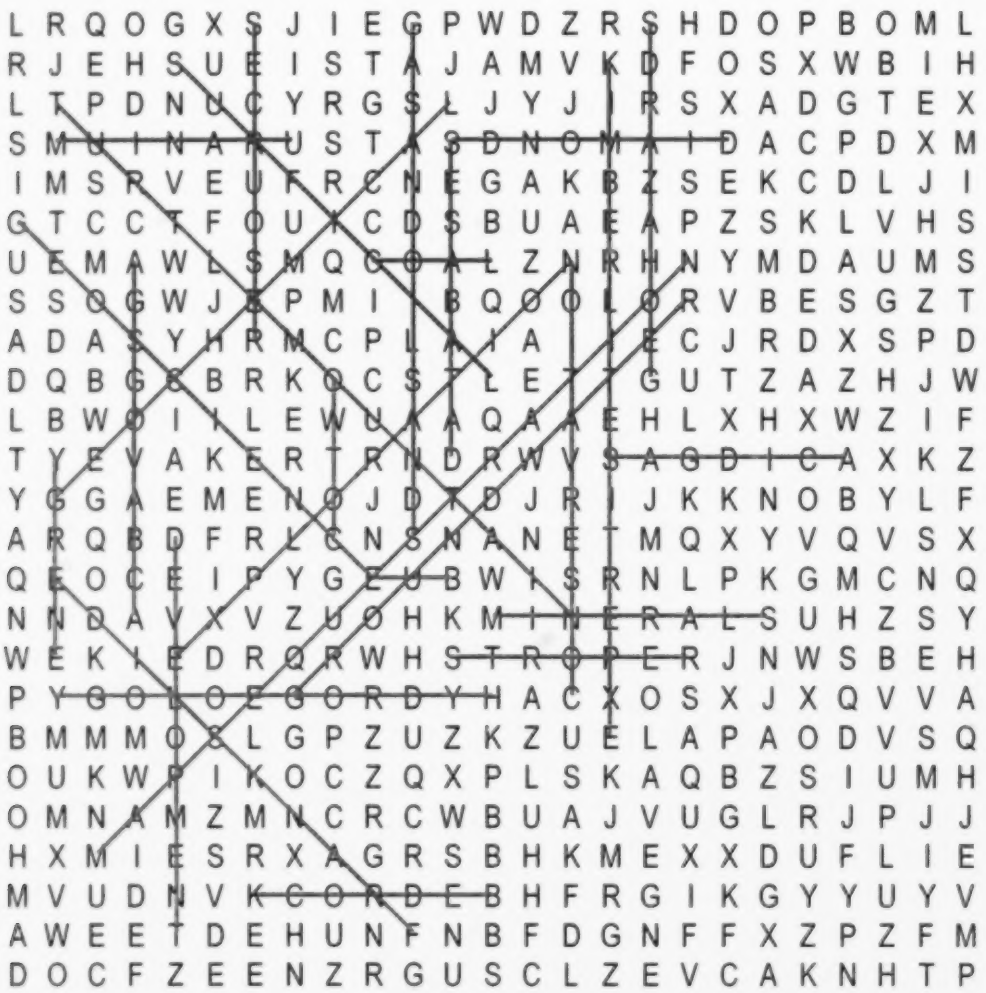

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GEO 2005-10 Quaternary Stratigraphy and Till Geochemistry of the southern Buffalo Head Hills: Results of an Auger Coring Program. 270 MB PDF. $20.00.

Earth Sciences Reports

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ESR 2005-05 Regional Stratigraphic Framework of Buffalo Head Hills—Peerless Lake Region, Northern Alberta. 8.66 MB PDF. $20.00

Information Series Reports

INF 133 MEG Forum 2005 Poster — Clear Hills Ironstone and Coal Resources — 2004 Digital Compilation and Some Geochemical and Geological Highlights from 2004 Fieldwork. 6.44 MB PDF. $10.00

Maps

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MAP 329 Drift Thickness of Zama Lake Area, Alberta (NTS 84L). 1:250 000 scale. 10.5 MB PDF.

Map 328 and 329 are sold together on 1 CD for $25.00.

Map 360 Surficial Geology of the Beatty Lake Area, Alberta (NTS 84M/NE). Scale 1:100 000. 19MB PDF. $20.00. **GSC Open File 5183.**

Map 361 Surficial Geology of the Zama City Area, Alberta (NTS 84M/SE). Scale 1:100 000. 29.55 MB PDF. $20.00. **GSC Open File 5184.**

Map 395 Surficial Geology, Thinahtea Creek, Alberta (84M/NW). Scale 1:100 000. 4.36 MB PDF. $20.00. **GSC Open File 5070.**

Mineral Assessment Reports

MIN 20040012 Assessment Report Pincher Creek Project, Metallic and Industrial Minerals Permit Number 9302030112. 12 p.

MIN 20040013 Assessment Report Permits 9302090597 and 9302050093 Pelican Mountains, Alberta. 107 p.

MIN 20040014 Geochemical Sampling, Airborne EM Survey and Diamond Drilling on the Liege Prospect Northern Alberta. 130 p., 3 maps.

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Mineral Assessment Report prices are determined at time of reproduction

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SPE 077 Geochemistry and Heavy Mineral Content of Glacial Sediments from Northwest Alberta (NTS 84L, 84M): New Opportunities for Mineral Exploration. 1.98 MB PDF. $20.00. **GSC Open File 5121.**

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April 25 – 27, 2006
Ramada Hotel Downtown
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Cold Lake Home and Leisure Trade Show
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Cold Lake Arena
Cold Lake, Alberta

Alberta's Environment Conference
May 2 – 5, 2006
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CSPG/CSEG/CWLS Annual Convention
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Calgary, Alberta

Geofluids V
May 17 – 21, 2006
Alumni Hall Conference Centre, University of Windsor
Windsor, Ontario

GeoAlberta
May 30 – June 1, 2006
Shaw Conference Centre
Edmonton, Alberta

8th International Conference on Greenhouse Gas Control Technologies
June 19 – 22, 2006
Trondheim, Norway

The Saskatoon CIM Geological Society Uranium Field Conference
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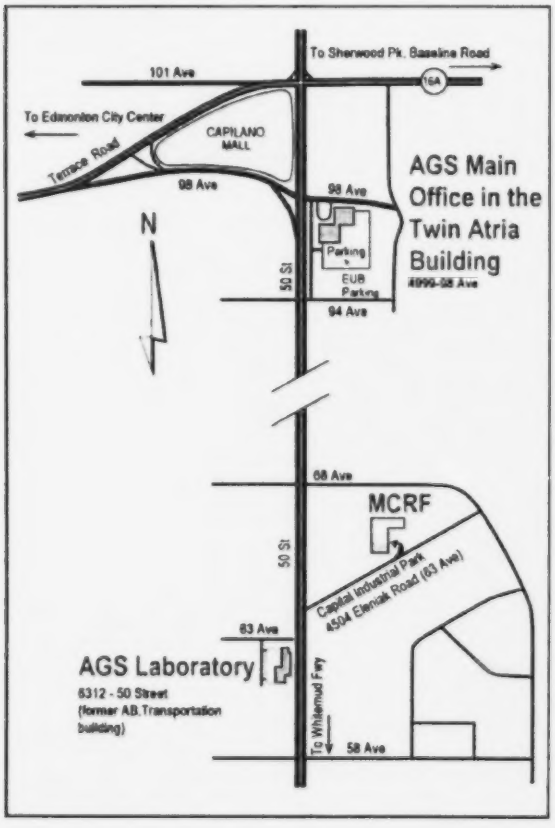

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Our Mineral Core Research Facility (MCRF) is located at

4504 Eleniak Road
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For information on the MCRF or to book a visit, contact Rob Natyshen by phone at (780) 466-1779 or by e-mail at Rob.Natyshen@gov.ab.ca